

# National Advisory Committee for Aeronautics

## Research Abstracts

NO. 31

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### CURRENT NACA REPORTS

NACA Rept. 1026

NACA INVESTIGATION OF FUEL PERFORMANCE IN PISTON-TYPE ENGINES. Henry C. Barnett. 1951. vi, 102p. diags., photos., 32 tabs. (NACA Rept. 1026)

A compilation of many of the pertinent research data acquired by the NACA on fuel performance in piston engines. The following specific subjects are discussed: High-speed photographic studies of knocking combustion, by C. David Miller; correlations of knock-limited performance data; antiknock performance scales; preignition; hydrocarbons and ethers as antiknock blending agents; aromatic amines as fuel additives; tetraethyl lead as a fuel additive; anti-knock blending characteristics of fuels; fuel volatility; and internal cooling.

NACA Rept. 1054

INTEGRALS AND INTEGRAL EQUATIONS IN LINEARIZED WING THEORY. Harvard Lomax, Max A. Heaslet and Franklyn B. Fuller. 1951. li, 34p. diags. (NACA Rept. 1054. Formerly TN 2252)

The formulas of subsonic and supersonic wing theory for source, doublet, and vortex distributions are reviewed, and a systematic presentation is provided which relates these distributions to the pressure and to the vertical induced velocity in the plane of the wing. It is shown that care must be used in treating the singularities involved in the analysis and that the order of integration is not always reversible. Concepts suggested by the irreversibility of order of integration are shown to be useful in the inversion of singular integral equations when operational techniques are used. A number of examples are given to illustrate the methods presented, attention being directed to supersonic flight speeds.

NACA Rept. 1065

CORRELATION OF PHYSICAL PROPERTIES WITH MOLECULAR STRUCTURE FOR SOME DICYCLIC HYDROCARBONS HAVING HIGH THERMAL-ENERGY RELEASE PER UNIT VOLUME-2-ALKYLBIPHENYL AND THE TWO ISOMERIC 2-ALKYLBICYCLOHEXYL SERIES. Irving A. Goodman and Paul H. Wise. 1952. 10p. diags., 2 tabs. (NACA Rept. 1065. Formerly TN 2419)

Three homologous series of related dicyclic hydrocarbons are compared on the basis of the following physical properties: net heat of combustion, density, melting point, boiling point, and kinematic viscosity. The three series investigated are the 2-alkylbiphenyl, and the high- and low-boiling 2-alkylbicyclohexyl series through C<sub>16</sub>. Comparisons are made on the following bases: (1) as members of an homologous series in which the compounds have similar structures and differ in molecular weight; (2) as isomers with the same molecular formula but different molecular structure due to branching of the side chain or geometrical isomerism; and (3) as compounds with the same carbon skeleton but different molecular formula due to hydrogenation of the aromatic ring.

NACA TN 2743

LANDING-GEAR IMPACT. W. Flügge, Stanford University. October 1952. 91p. diags., 9 tabs. (NACA TN 2743)

The report deals with the impact forces in landing gears. Both the landing impact and the taxiing impact have been considered, but drag forces have so far been excluded. The differential equations are developed and their numerical integration is shown, considering the nonlinear properties of the oleo shock strut. A way is shown for determining the dimensions of the metering pin from a given load-time diagram. A review of German literature on landing-gear impact is also presented.

NACA TN 2782

BENDING OF THIN PLATES WITH COMPOUND CURVATURE. H. G. Lew, Pennsylvania State College. October 1952. 49p. diags., 2 tabs. (NACA TN 2782)

A method is developed for analysis of deformations of doubly curved thin plates under edge or surface loads for small deflections. The problem is approached from thin-shell theory so that the plate is to form part of a shell of revolution. An analytical solution is presented completely for a plate with arbitrary meridian of small curvature loaded by normal edge loads on one pair of opposite edges and numerical calculations are given for the deflection and moment distribution for a particular meridian curve. The method developed may be applied to other problems of bending of doubly curved thin plates under edge or surface loads but the theory is limited to small deflections of the plate considered.

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## NACA TN 2790

FLOW STUDIES IN THE VICINITY OF A MODIFIED FLAT-PLATE RECTANGULAR WING OF ASPECT RATIO 0.25. William H. Michael, Jr. September 1952. 33p. diagrs., photos. (NACA TN 2790)

Studies were made of the flow in the vicinity of a modified flat-plate rectangular wing of aspect ratio 0.25 by the use of photographs of a tuft grid located at various chordwise positions on the wing and behind the wing, supplemented by wake studies with a yaw-head pitot-tube installation. Evaluations were made concerning the rolling-up of the trailing vorticity, vorticity distribution in the wake, chordwise growth of lift, and locations of the vortex cores.

## NACA TN 2794

A COMPARISON OF TWO METHODS OF LINEARIZED CHARACTERISTICS FOR A SIMPLE UNSTEADY FLOW. Roger D. Sullivan. September 1952. 28p. diagrs. (NACA TN 2794)

Two methods of using the concept of linearized characteristics are derived for the one-dimensional unsteady flow in a tube that is rotated about an axis perpendicular to the axis of the tube. One of the methods corresponds to that used by Ferri in his basic work on the subject. Solutions are made by both methods for boundary conditions that allow analytic solutions. Comparisons shows that both methods give the same results but there are significant differences in their application.

## NACA TN 2796

EXPERIMENTAL STUDY OF THE EFFECTS OF FINITE SURFACE DISTURBANCES AND ANGLE OF ATTACK ON THE LAMINAR BOUNDARY LAYER ON AN NACA 64A010 AIRFOIL WITH AREA SUCTION. Milton A. Schwartzberg and Albert L. Braslow. October 1952. 35p. diagrs. (NACA TN 2796)

A Langley low-turbulence wind-tunnel investigation of a porous NACA 64A010 airfoil section has been made to determine the effectiveness of area suction in maintaining full-chord laminar flow behind finite disturbances and at angles of attack other than  $0^\circ$ . Area suction resulted in only a small increase in the size of a finite disturbance required to cause premature boundary-layer transition as compared with that for the airfoil without suction. Combined wake and suction drags lower than the drag of the plain airfoil were obtained through a range of low lift coefficient by the use of area suction.

## NACA TN 2797

A STUDY OF THE TRANSIENT BEHAVIOR OF SHOCK WAVES IN TRANSONIC CHANNEL FLOWS. Robert V. Hess. October 1952. 32p. diagrs. (NACA TN 2797)

The accuracy of the result obtained in a fundamental paper by Kantrowitz (NACA TN 1225) that a small short-time lowering of the back pressure in steady, shock-free, transonic diffuser flow causes a stationary or trapped shock to form near the critical sonic channel throat is investigated by considering the contribution of a higher-order term in the short-time calculations which was neglected in Kantrowitz's paper. In this higher approximation to the short-time effects, the shock is no longer stationary or trapped unless it is supported by a negative steady-flow back pressure; the result thus is no longer in disagreement with steady-flow solutions for stationary shocks.

## NACA TN 2798

AN EXPERIMENTAL INVESTIGATION OF THE BEHAVIOR OF 24S-T4 ALUMINUM ALLOY SUBJECTED TO REPEATED STRESSES OF CONSTANT AND VARYING AMPLITUDES. Herbert F. Hardrath and Elmer C. Utley, Jr. October 1952. 23p. diagrs., 4 tabs. (NACA TN 2798)

A device for adapting R. R. Moore rotating-beam fatigue testing machines for tests in which the amplitude of stress is continuously varied is described. Tests of 24S-T4 aluminum-alloy specimens subjected to stresses of constant amplitude and to stresses with amplitudes varying according to sinusoidal and exponential functions are reported. The results are analyzed by computing the summation of cycle ratios. The values obtained in this analysis were found to be influenced by the shape of the frequency-distribution curve.

## NACA TN 2800

SOLUTIONS OF LAMINAR-BOUNDARY-LAYER EQUATIONS WHICH RESULT IN SPECIFIC-WEIGHT-FLOW PROFILES LOCALLY EXCEEDING FREE-STREAM VALUES. W. Byron Brown and John N. B. Livingood. September 1952. 36p. diagrs., 2 tabs. (NACA TN 2800)

Revised solutions of the laminar-boundary-layer equations for cases which involved cooling at the wall combined with large pressure gradients in the main stream produced specific-weight-flow profiles which locally exceeded free-stream values. Heat-transfer and friction coefficients, boundary-layer thicknesses, and velocity, temperature, and specific-weight-flow distributions resulting from the revised solutions are presented for Euler numbers of 0.5 and 1, stream-to-wall temperature ratios of 2 and 4, and cooling-air flow rates through porous walls designated by flow parameters of 0, -0.5, and -1.

## NACA TN 2801

INVESTIGATION WITH AN INTERFEROMETER OF THE FLOW AROUND A CIRCULAR-ARC AIRFOIL AT MACH NUMBERS BETWEEN 0.6 AND 0.9. George P. Wood and Paul B. Gooderum. October 1952. 80p. diagrs., photos., tab. (NACA TN 2801)

The flow around a 12-percent-thick circular-arc airfoil at zero incidence was observed by use of an interferometer for small increments of free-stream Mach number from 0.609 to 0.896 with laminar and turbulent boundary layers. Mach number contours in the flow field and Mach number and pressure distributions on the airfoil were obtained. Conditions were determined along and at the bases of the shock waves that interacted with the turbulent boundary layer on the airfoil.

#### NACA TN 2802

**BONDING OF MOLYBDENUM DISULFIDE TO VARIOUS MATERIALS TO FORM A SOLID LUBRICATING FILM. II - FRICTION AND ENDURANCE CHARACTERISTICS OF FILMS BONDED BY PRACTICAL METHODS.** Douglas Godfrey and Edmond E. Blsson. October 1952. 16p. diagrs. (NACA TN 2802)

The use of molybdenum disulfide  $\text{MoS}_2$  as a solid-film lubricant, in applications where designs or higher temperatures preclude liquid lubricants, is extended because of the good frictional and thermal characteristics of  $\text{MoS}_2$ . An investigation was conducted to determine (1) practical methods of bonding  $\text{MoS}_2$  to materials to form solid-film lubricants and (2) friction and endurance characteristics of films so formed. The results indicated that satisfactory films can be formed by brushing on a mixture of  $\text{MoS}_2$  powder and a resin-forming vehicles such as: thinned asphalt-base varnish, silicone-base varnish, or glycerol (1 part, by weight,  $\text{MoS}_2$ , 2 parts vehicle). Choice of vehicle is governed by application, cleaning, and temperature of curing. Friction and endurance data obtained under high sliding velocities and high surface stress showed that solid-film lubricants (between 0.0002 and 0.0005 in. thick) of  $\text{MoS}_2$ , bonded with the various resins including corn-syrup resin, resulted in good lubricating effectiveness.

#### NACA TN 2803

**A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF TEMPERATURE GRADIENTS ON THE DEFORMATION AND BURST SPEEDS OF ROTATING DISKS.** P. I. Wiltedink, A. G. Holms and S. S. Manson. October 1952. 45p. diagrs., photo., 2 tabs. (NACA TN 2803)

The purposes of this investigation were to evaluate the influence of temperature gradients and to test the validity of a recently developed method of calculating plastic flow in disks by comparing the calculated results with experimental observations. Short-time spin tests on parallel-sided, 10-inch-diameter disks were conducted under conditions that subjected the disks to a range of temperatures from  $70^\circ$  to  $1440^\circ\text{F}$ . The agreement between the theoretical and experimental results was good over the range of temperature conditions investigated. Temperature gradients produced little reduction in the burst speed of the disks which had a high ductility.

#### NACA TN 2804

**THE PLANING CHARACTERISTICS OF A SURFACE HAVING A BASIC ANGLE OF DEAD RISE OF  $20^\circ$  AND HORIZONTAL CHINE FLARE.** Walter J. Kapryan and Irving Weinstein. October 1952. 42p. diagrs., photos., 2 tabs. (NACA TN 2804)

A high-speed investigation was conducted to determine the hydrodynamic characteristics of a planing surface having an angle of dead rise of  $20^\circ$  and horizontal chine flare. The data indicate that the planing characteristics at a given trim depend only on lift coefficient. The ratio of center-of-pressure location to the mean wetted length can be considered approximately equal to 0.67 up to  $18^\circ$  of trim. This ratio decreases with further increase in trim. Pile-up of water at the keel of the model was substantial at trims above  $12^\circ$ . Friction drag is negligible at high trims. The resistances for trims of  $18^\circ$  and higher, therefore, may be assumed equal to the load times the tangent of the trim angle.

#### NACA TN 2807

**MEASUREMENTS OF TEMPERATURE VARIATIONS IN THE ATMOSPHERE NEAR THE TROPOPAUSE WITH REFERENCE TO AIRSPEED CALIBRATION BY THE TEMPERATURE METHOD.** Lindsay J. Lina and Harry H. Ricker, Jr. October 1952. 23p. diagrs., tab. (NACA TN 2807)

Measurements of temperature variations in the atmosphere near the tropopause over land in the vicinity of Langley Field, Va., are presented. This investigation was made for the purpose of obtaining information on the accuracy of the temperature method (NACA TN 2046) of airspeed calibration over the range of Mach number from 0.6 to 0.8. The temperature surveys and the description of a specially designed thermometer are also presented.

#### NACA TN 2808

**SHORT-BEARING APPROXIMATION FOR FULL JOURNAL BEARINGS.** F. W. Ocvirk. Cornell University. October 1952. 61p. diagrs. (NACA TN 2808)

A short-bearing approximation of pressure distribution in the oil film is presented which is an extension of the pressure-distribution function of Michell and Cardullo and includes end-leakage effects. Equations giving applied load, attitude angle, location and magnitude of peak film pressure, friction, and required oil flow rate as functions of the eccentricity ratio are also given. The capacity number, a basic nondimensional quantity resulting from this analysis, is the product of the Sommerfeld number and the square of the length-diameter ratio. Curves determined by this analysis are compared with previously published experimental data and theoretical curves of Sommerfeld and Cameron and Wood. Conclusions reached indicate that this approximation is of practical value for analysis of short bearings.

## NACA TN 2810

National Advisory Committee for Aeronautics.  
**ONE-DIMENSIONAL ANALYSIS OF CHOKED-FLOW  
TURBINES.** Robert E. English and Richard H.  
Cavicchi. October 1952. 53p. diagsr. (NACA  
TN 2810)

Flow conditions internal to choked-flow turbines were subjected to a one-dimensional analysis. Factors affecting the design, operation, and manufacture of such turbines were investigated. Criteria are presented which will aid in analysis of test data from such turbines. The effect of turbine-stator adjustment on internal flow conditions was investigated for one application of turbine stator adjustment.

## NACA RM E52H01

National Advisory Committee for Aeronautics.  
**LUMPED REFLECTOR PARAMETERS FOR TWO-  
GROUP REACTOR CALCULATIONS.** Daniel Fieno,  
Harold Schneider and Robert B. Spooner. September  
1952. 25p. diagsr., tab. (NACA RM E52H01)

Equations are developed to show that, for one-dimensional two-group neutron-distribution calculations, the properties of a neutron-reflector region can be combined in three parameters that effectively represent the action of the reflector. The use of these parameters and boundary conditions based on them for single and multizone reflectors is considered and from the results of computations, the following applications of the parameters are shown: (1) Use of the parameters in connection with reactor core properties for comparison of reflector configurations, (2) direct use of parameters as circuit constants in electrical analog, and (3) use of boundary conditions based on reflector parameters to obtain numerical solutions of two-group equations in a neutron-producing region.

## NACA RM E52H11

National Advisory Committee for Aeronautics.  
**INVESTIGATION OF FLOW FLUCTUATIONS AT  
THE EXIT OF A RADIAL-FLOW CENTRIFUGAL  
IMPELLER.** Joseph T. Hamrick and John Mizisin.  
October 1952. 20p. diagsr., photo. (NACA  
RM E52H11)

Surveys were made at the exit of a radial-flow centrifugal impeller to obtain instantaneous values of velocity from blade to blade and at various positions between the front and rear diffuser walls. Surveys were also made at several radial stations midway between the walls of the diffuser to observe the radial change in flow pattern. At the impeller exit, there were variations in velocity patterns across each passage from passage to passage, and for the same passage from revolution to revolution. The general flow patterns persisted into the diffuser and were still evident at a radius 23 percent greater than that of the impeller.

**BRITISH REPORTS**

N-17478\*

Royal Aircraft Establishment (Gt. Brit.)  
**CABIN COOLING FLIGHT TESTS ON A TUDOR 2  
AIRCRAFT.** D. A. Hancock and T. J. Methven.  
March 1952. 45p. diagsr., photos., 4 tabs. (RAE  
Tech. Note Mech. Eng. 118)

This note describes a series of flight tests made on a Tudor 2 aircraft as the first stage of the practical determination of the heat loss or gain of aircraft cabins in flight. The prime object of these tests, which were made with an air cycle refrigerator (type C. A. 7.) fitted to the aircraft ventilation system was to obtain data on cabin cooling; but as the refrigerator installation was fully instrumentated, measurements of its performance were obtained. It was found that owing to the large number of variables present and the difficulty in obtaining identical ambient conditions for any two flights, the results obtained were not completely conclusive. It is possible, however, to make general deductions for this particular aircraft, and to indicate future investigations.

N-17479\*

Royal Aircraft Establishment (Gt. Brit.)  
**INVESTIGATION OF RETRACTABLE AILERONS ON  
RECTANGULAR WING OF PROFILE S. O. 2915.  
(EXPERIMENTS IN THE BANLÈVE WIND TUNNEL  
NO. 777, FEBRUARY, 1948).** May 1952. 22p.  
diagsr. (RAE Library Trans. 407. Trans. from  
Société Nationale de Constructions Aéronautiques du  
Sud-Ouest. G/9)

The present report completes the investigation of retractable ailerons for the SO. 8000 on a model of a rectangular wing of profile SO. 29 - 15, 1 metre span and 0.50-m chord quoted in report G/7 of October 1947. The experiments were resumed with type II slotted spoiler (rake type) of which a detailed description is given.

N-17498\*

Royal Aircraft Establishment (Gt. Brit.)  
**THE PERFORMANCE OF VARIOUS TYPES OF  
RESISTANCE THERMOMETERS FOR OUTSIDE AIR  
TEMPERATURE MEASUREMENTS FROM AIR-  
CRAFT.** D. C. Austin. April 1952. 17p. photos.  
(RAE Tech. Note EL. 28)

This note gives results and details of a number of flight tests carried out on eight variations of resistance thermometer installations for measurement of outside air temperature from service aircraft. The purpose of the tests was to determine the most suitable type of installation for general service use and to find an alternative thermometer to the existing flat plate type. The magnitude of the possible error due to the velocity of the aircraft is shown and the method of determining this error is given in detail for

information and also as a basis of comparison with similar tests carried out by other establishments. The errors which arise due to other causes are also detailed to indicate the over-all accuracy which can be expected. The thermometer bulbs tested and their associated indicators constitute systems which are considered suitable for installation in all types of aircraft as distinct from the more precise and accurate thermometric systems installed on meteorological aircraft.

N-17499\*

Royal Aircraft Establishment (Gt. Brit.)  
A MODULATOR CIRCUIT OF THE MAGNETIC  
AMPLIFIER TYPE. J. Baranowski. March 1952.  
4lp. diagsr. (RAE Tech. Note EL. 34)

A transducer type modulator with two cores and two cooper-oxide rectifiers which gives a duo-directional d-c. output is described. Current gains of 10 to 20 and power gains of up to a thousand are obtained in a single stage and the output may be fed into a similar modulator or into a conventional magnetic amplifier. A 400 c/s three stage amplifier is also described which incorporates two such modulator circuits and which has a power gain of  $10^8$  (current gain 1000) for a response time of 0.14 sec with a long term zero stability of  $2 \times 10^{-11}$  watt input power. With further development it is considered that this zero stability could be improved, possibly by a factor of 10.

N-17503\*

Royal Aircraft Establishment (Gt. Brit.)  
A SIMPLE ESTIMATE OF THE PROFILE DRAG OF  
SWEEP WINGS. J. Weber and G. G. Brebner.  
June 1952. 14p. diagsr., tab. (RAE Tech. Note  
Aero 2168)

It is shown that the profile drag of swept wings near zero lift can be calculated much more simple than might be expected in view of the complicated nature of the three-dimensional boundary layer. Following the approach of Young and Booth, simple charts are derived for obtaining a drag reduction factor due to sweep. The profile drag of a swept wing may be obtained by applying this factor to the results of Squire and Young for two-dimensional airfoils, if the transition position on the swept wing is known. Results of such a calculation are confirmed by experimental data from a  $45^\circ$  sweptback wing of aspect ratio 3.

N-17505\*

Royal Aircraft Establishment (Gt. Brit.)  
THEORETICAL LOAD DISTRIBUTION ON A WING  
WITH A CYLINDRICAL BODY AT ONE END.  
J. Weber. June 1952. 27p. diagsr. (RAE  
Aero 2467)

A method is derived for calculating the spanwise load distribution over a lifting wing having a long

circular-cylindrical body at one end. The solution is derived for arrangements giving minimum induced drag, but can be generalized to obtain approximate results for other plan forms including those with sweepback. Charts are given for the case in which the sectional lift slope is constant along the span. The lift distribution over both wing and body can be determined quickly, or the over-all load obtained directly. The results are applicable to the determination of side forces on a fin in combination with the rear fuselage of an aircraft, or of the lift loading on a wing with a weapon or fuel tank at one tip.

## MISCELLANEOUS

NACA TN 2599

Errata No. 1 on "EXPERIMENTAL DETERMINATION OF TIME CONSTANTS AND NUSSELT NUMBERS FOR BARE-WIRE THERMOCOUPLES IN HIGH-VELOCITY AIR STREAMS AND ANALYTIC APPROXIMATION OF CONDUCTION AND RADIATION ERRORS". Marvin D. Scadron and Isidore Warshawsky. January 1952.

## UNPUBLISHED PAPERS

N-17248\*

THE ROLE OF ELECTRIC POWER IN SUPERSONIC FLIGHT. A. G. Buck. 1952. 8p. (To be delivered before the San Francisco chapter of American Institute of Electrical Engineers on September 12, 1952).

This report gives a brief discussion of some of the many phases of electrical engineering which have gone into the achievement of supersonic flight.

N-17249\*

MINIATURE PRESSURE CELLS. Taft Wrathall. 1952. 29p. diagsr., photos. (To be presented at Instrument Society of America conference & exhibit, Cleveland, Ohio, September 8, 1952).

It is the purpose of this paper to show in general terms what has been done by the National Advisory Committee for Aeronautics, in the development of small pressure cells. Construction details and characteristics are briefly discussed.

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